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CHEMICAL EXAMINATION

OF THE BARK OF

EUONYMUS ATROPURPUREUS

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CIX.—*Chemical Examination of the Bark of* Euonymus atropurpureus.

By Harold Rogerson.

Euonymus atropurpureus, Jacquin (Nat. Ord. *Celastraceae*), is a shrub indigenous to the northern and western States of North America, where it is known by the common names of "wahoo" and "burning bush." It is frequently cultivated on account of

its copious crimson fruit. The root-bark of the plant has been employed to a considerable extent medicinally, and is recognised by both the British and United States Pharmacopœias. A crude, resinous product, as well as an alcoholic extract of the drug, has met with somewhat extended use under the name of "Euonymin," and this appellation has also been given to various other substances obtained from the bark, all of which, however, appear to have been of a very indefinite character.

One of the earliest chemical examinations of *Euonymus* was by Wenzell (*Amer. J. Pharm.*, 1862, **34**, 385), who stated that the bark contained an amorphous, neutral, bitter principle, termed "euonymin," several resins, organic acids, including the so-called "euonic acid," a substance resembling asparagine, sugar, etc. In some notes on the subject by Prescott (*ibid.*, 1878, **50**, 563), the euonymin of Wenzell is referred to as a glucoside, and said to have been obtained by Miller as a white, intensely bitter, uncrystallisable solid, but no further information was given respecting its composition or glucosidic character.

Schmiedeberg (*Arch. exp. Path Pharm.*, 1883, **16**, 163) refers to an hitherto unpublished investigation by Hans Meyer, and records the following statement: "Euonymin.—A glucoside, sparingly soluble in water, but readily in alcohol, which, in amounts of 1/15—1/10 of a milligram, arrests the action of a frog's heart in systole. It crystallises in colourless, cauliflower-like masses, which consist of radiating groups of needles, and is found in small amount in the resinoid of the same name from *Euonymus atropurpureus*." In a dissertation by G. Romm, Dorpat (*Pharm. Centr-h.*, 1885, **26**, 220), it is also recorded that Meyer had obtained a crystalline glucoside from the bark of *Euonymus atropurpureus*, which agrees in its action with digitalin, and a method was given for its preparation (compare van Ryn, "Die Glykoside," p. 287). The characters of this substance do not appear, however, to have been further determined, since no melting point or analysis was recorded, nor have any facts been noted which would serve to establish its glucosidic nature. It was stated by Romm (*loc. cit.*) that the so-called "euonymin" is contained in larger proportion in the bark of the branches than in that of the root of the above-mentioned species of *Euonymus*, and that there is none of it in *Euonymus europaeus*, Linné.

More recently, Naylor and Chaplin (*Year-book of Pharmacy*, 1889, 405) examined the bark of *Euonymus atropurpureus*, and isolated a crystalline substance melting at about 182°, which they regarded as a glucoside, and designated "atropurpurin." The same authors (*Pharm. J.*, 1889, [iii], **20**, 472) subsequently obtained this

substance in a purer form, and found that it was not a glucoside, since it did not reduce Fehling's solution after boiling for three hours with aqueous sulphuric acid. From the results of an analysis it was considered to be "either identical with, or an isomeride of, dulcite." The presence of dulcitol in the bark has since been confirmed by M. Hoehnel (*Pharm. Zeit.*, 1900, **45**, 210).

From the above brief résumé of the literature it will be seen that, with the exception of the occurrence of dulcitol, nothing of a very definite nature has been known regarding the constituents of euonymus bark. It was therefore deemed of interest to subject it to a complete examination, and the results obtained are embodied in the present communication.

Experimental.

The material employed in the present investigation consisted of a good quality of the root-bark of *Euonymus atropurpureus*, Jacquin, which conformed in its characters to the description given in the Pharmacopœias.

As a preliminary experiment, a small quantity (10 grams) of the ground material was tested for the presence of an alkaloid, but with a negative result.

Twenty-five grams of the ground bark were extracted in a Soxhlet apparatus with various solvents, when the following amounts of extract dried at 100° were obtained:

Petroleum extracted	0·50 gram	=	2·00	per cent.
Ether ,,	0·20 ,,	=	0·80	,, ,,
Chloroform ,,	0·25 ,,	=	1·00	,, ,,
Alcohol ,,	3·05 ,,	=	12·20	,, ,,
Total	4·00 grams	=	16·00	per cent.

For a complete examination of the drug a quantity (22·79 kilograms) of the ground material was thoroughly extracted by continuous percolation with hot alcohol. After removing most of the alcohol, a dark-coloured extract amounting to 7·95 kilograms was obtained.

Distillation of the Extract with Steam. Separation of an Essential Oil.

The above-mentioned extract was subjected to distillation in a current of steam until all the volatile constituents had passed over. The distillate, which contained a small amount of solid substance and some oily drops floating on the surface, was extracted with ether. The ethereal liquid was dried, and the solvent removed, when a small quantity (2·3 grams) of an essential oil was obtained.

The yield of the latter was thus equivalent to 0·01 per cent. of the weight of the drug. On keeping, it deposited a crystalline solid melting at 120°, which evidently was identical with the acid subsequently isolated in much larger amount as described below.

The essential oil, which possessed a pale yellow colour and pleasant odour, distilled between 120° and 160°/25 mm., and gave the colour reaction for furfuraldehyde.

Non-volatile Constituents of the Extract.

After the distillation of the extract with steam as above described, there remained in the distillation flask a dark-coloured aqueous liquid (*A*) and a quantity of a dark brown resin (*B*). These products, when cold, were separated by filtration, and the resin repeatedly washed with hot water until nothing further was removed, the washings being added to the original filtrate.

Examination of the Aqueous Liquid (A).
Isolation of Dulcitol, $C_6H_{14}O_6$.

The aqueous liquid and washings were concentrated under diminished pressure, when, on cooling, a quantity of a crystalline substance separated. This was removed by filtration, and a further amount was obtained by adding alcohol to the liquid. The total amount of solid isolated was 475 grams, which is equivalent to 2·09 per cent. of the weight of ground root-bark employed. A portion of the substance was recrystallised from water with the use of a little animal charcoal, when it was obtained in large, well-defined prisms melting at 186—188°. The aqueous solution was optically inactive. (Found, C = 39·2; H = 7·7. Calc., C = 39·6; H = 7·7 per cent.)

The substance is thus seen to be dulcitol, the occurrence of which in *Euonymus* bark had previously been observed.

In order, however, to further characterise the above-described substance, a quantity of it was acetylated by means of acetic anhydride. The solid obtained on pouring the cooled liquid into water was collected and recrystallised from absolute alcohol, when hexa-acetyldulcitol separated in lustrous, flat needles, melting at 168—169°. (Found, C = 49·5; H = 6·3. Calc., C = 49·7; H = 6·0 per cent.)

The benzoylation of dulcitol has previously been recorded by Bouchardat (*Ann. Chim. Phys.*, 1872, [iv], **27**, 163), who states that the hexabenzoyl derivative melts at 147° and sublimes at 220°. On benzoylating a quantity of the substance by the Schotten-Baumann method, a product was obtained which apparently was

not a pure substance. Several other methods were therefore investigated, when the following one was found to give a quantitative yield of hexabenzoyldulcitol: Five grams of pure dulcitol were heated with 70 grams of pyridine, and 30·5 grams of benzoyl chloride gradually introduced. The dulcitol slowly dissolved, and, after boiling for fifteen minutes and cooling, the liquid was poured into water. The precipitated solid was collected and well washed. On recrystallising this product from a mixture of ether and chloroform (equal volumes), the substance separated in well-defined, colourless prisms melting at 189—191° without decomposition. Recrystallisation from the above solvent, or from a mixture of pyridine and alcohol, did not change the melting point of the substance:

0·1892 gave 0·4944 CO_2 and 0·0830 H_2O. C = 71·3; H = 4·9.

$C_{48}H_{38}O_{12}$ requires C = 71·5; H = 4·7 per cent.

Hexabenzoyldulcitol is very soluble in chloroform and pyridine, but only sparingly soluble in ether or boiling alcohol. It is also optically inactive, and does not sublime at 280°. It is therefore evident that the product obtained by Bouchardat (*loc. cit.*) was very impure.

Isolation of a New Acid, Furan-β-monocarboxylic Acid, $C_5H_4O_3$.

After the removal of the dulcitol, as described above, the aqueous liquid was deprived of alcohol by means of a current of steam, and then thoroughly extracted with ether. The ethereal liquid was extracted with aqueous ammonium carbonate, when, on acidifying the alkaline liquid, a quantity of a viscid product was precipitated. This was dissolved in ether, the ethereal liquid being dried and the solvent removed. On keeping the resulting product for some days, a substance was deposited in prismatic needles. This was collected, and, after washing with a little ethyl acetate, recrystallised from water, when a quantity (9 grams) of substance separated in anhydrous laminæ melting at 121—122°:

0·1307 gave 0·2562 CO_2 and 0·0452 H_2O. C = 53·5; H = 3·8.

$C_5H_4O_3$ requires C = 53·6; H = 3·6 per cent.

Two determinations of the molecular weight of the substance, by Barger's microscopic method, gave the following results:

(1) 0·058 in 0·913 ethyl acetate, using benzil as the standard, was between 0·475 and 0·5 mol.

(2) 0·063 in 1·642 alcohol, using azobenzene as the standard, was between 0·32 and 0·30 mol.

(1) Mean M.W. = 130. (2) Mean M.W. = 124.

$C_5H_4O_3$ requires M.W. = 112.

The above-described substance was found to be a monocarboxylic acid, and evidently possesses the formula $C_5H_4O_3$. It is isomeric with pyromeconic acid (m. p. 122°) and with furan-α-carboxylic acid (m. p. 132—133°), but not being identical with either of these substances it is evidently a new compound, and must be *furan-β-carboxylic acid*. It is hoped to confirm this conclusion by the synthesis of the last-mentioned acid.

Furan-β-carboxylic acid is sparingly soluble in cold water, but readily soluble in hot water, ethyl acetate, and alcohol. Its aqueous solution gives no colour with ferric chloride. The acid is volatile in steam, and sublimes at 110°.

Silver Furan-β-carboxylate, $C_5H_3O_3Ag$.—This salt was obtained as a white, granular powder:

0·0888 gave 0·0436 Ag. Ag = 49·1.

$C_5H_3O_3Ag$ requires Ag = 49·3 per cent.

Methyl Furan-β-carboxylate, $C_6H_6O_3$.—This derivative of the acid was prepared by dissolving the latter in methyl alcohol, and saturating the solution with dry hydrogen chloride. It was a colourless liquid, boiling at 160° under the ordinary pressure, and possessed an odour very similar to that of methyl benzoate:

0·1688 gave 0·3512 CO_2 and 0·0768 H_2O. C = 56·7; H = 5·0.

$C_6H_6O_3$ requires C = 57·1; H = 4·8 per cent.

The density and refractive index of methyl furan-β-carboxylate were determined, with the following result:

$$D_{15}^{15} = 1{\cdot}1744;\ n_D^{20} = 1{\cdot}46759.$$

It was deemed of interest to compare the above-described constants with those of methyl furan-α-carboxylate (methyl pyromucate), and for this purpose a quantity of the last-mentioned ester was prepared from a pure specimen of pyromucic acid (m. p. 133°). The product was a colourless liquid, boiling at 181° under ordinary pressure, and possessing an odour which slightly resembled that of methyl benzoate. This ester had $D_{15}^{15} = 1{\cdot}1739$; $n_D^{20} = 1{\cdot}48599$ (compare Gennari, *Gazzetta*, 1894, **24**, [i], 253).

Stenhouse (Trans., 1872, **25**, 298) has described an acid (m. p. 130°), which he regarded as β-pyromucic acid. This was prepared from an aldehyde obtained from various species of *Fucus*, which he termed "fucusol." No doubt can be entertained, however, that the acid described by Stenhouse was really somewhat impure pyromucic acid.

The original ethereal liquid, after treatment with ammonium carbonate as described above, was extracted with solutions of sodium carbonate and sodium hydroxide respectively, but only traces of amorphous material were thus removed.

Isolation of a New Crystalline Alcohol, Euonymol, $C_{21}H_{30}O_4$.

The ethereal liquid which had been extracted with alkalis, as just described, was dried, and the solvent removed, when a small amount (1·5 gram) of a viscid product was obtained. This product, on keeping, deposited a small quantity (0·5 gram) of a crystalline substance, which was collected and recrystallised from a mixture of ether and ethyl acetate, when it was obtained in prisms melting at 248—250°:

0·1085 gave 0·2888 CO_2 and 0·0871 H_2O. C = 72·6; H = 8·9.

$C_{21}H_{30}O_4$ requires C = 72·8; H = 8·7 per cent.

The above-described compound is thus seen to be an alcohol, which evidently possesses the formula $C_{21}H_{30}O_4$. No substance of this formula having hitherto been described, it must be regarded as a new compound, and, with reference to its properties and the generic name of the plant from which it has been isolated, it is proposed to designate it *euonymol.*

Euonymol possesses a very bitter taste which is more apparent when dissolved in alcohol. If a crystal of the substance be dissolved in a small quantity of acetic anhydride, and a few drops of concentrated sulphuric acid then added, a pink colour is soon developed, which rapidly changes to green, showing a bronze fluorescence, and finally becomes yellow. Euonymol slowly dissolves in sulphuric acid, giving a yellow solution, which shows a brilliant, greenish-yellow fluorescence.

A small quantity of the substance was heated with acetic anhydride, and the resulting product recrystallised from a mixture of ether and ethyl acetate. On cooling, an *acetyl* derivative separated in well-defined, rectangular prisms melting at 215°, but the amount was too small for analysis.

The original aqueous liquid which had been extracted with ether, as described above, was next shaken with chloroform and then with amyl alcohol, but these solvents removed only small amounts of amorphous material, from which nothing definite could be obtained.

The aqueous liquid was distilled in a current of steam in order to remove the amyl alcohol, and, after cooling, was treated with a slight excess of a solution of basic lead acetate. The small amount of precipitate thus produced was collected, washed, suspended in water, and decomposed by hydrogen sulphide. The mixture was filtered, and the filtrate concentrated under diminished pressure to a small volume. This liquid gave a dark brown colour with ferric chloride, but nothing definite could be isolated from it.

The filtrate from the lead precipitate was treated with hydrogen

sulphide for the removal of the lead, and, after filtering, was concentrated under diminished pressure to the consistency of a syrup. This contained a quantity of sugar, since it readily reduced Fehling's solution, and yielded *d*-phenylglucosazone melting at 208—209°.

Examination of the Resin (B).

This was a dark brown, soft solid, and amounted to about 730 grams, being thus equivalent to 3·2 per cent. of the drug. It was dissolved in alcohol, mixed with purified sawdust, and the thoroughly dried mixture successively extracted in a Soxhlet apparatus with light petroleum (b. p. 40—60°), ether, chloroform, ethyl acetate, and alcohol.

Petroleum Extract of the Resin.

This was a dark brown mass, which amounted to 460 grams. It was dissolved in ether, and the ethereal liquid extracted successively with aqueous ammonium and sodium carbonates, but nothing was removed by this treatment. The ethereal solution was therefore distilled, and the residue heated in alcoholic solution with an excess of potassium hydroxide. The alcohol was then removed, and, after cooling, water was added and the alkaline liquid thoroughly extracted with ether. The ethereal liquid was dried, and the solvent evaporated, when there remained a quantity (70 grams) of a viscid mass, which became solid on cooling. This was dissolved in a large volume of alcohol, when, on keeping for some days, a quantity (12 grams) of a crystalline product separated in flat needles. On recrystallising this product from a mixture of ethyl acetate and dilute alcohol, it separated in laminæ melting at 135—136°, which gave colour reactions similar to those of the phytosterols.

Isolation of a New Monohydric Alcohol, Euonysterol, $C_{31}H_{51}O{\cdot}OH$.

The above-described product was found to be a mixture, and, after fractional crystallisation, each fraction was converted into its acetyl derivative, and these recrystallised several times. In this way, small amounts of amorphous material were eliminated. The acetyl derivatives were then hydrolysed with alcoholic potassium hydroxide, and the resulting products recrystallised from a mixture of ethyl acetate and dilute alcohol. The principal fraction consisted of flat needles melting at 137—138°:

0·2494, on heating at 110°, lost 0·0132 H_2O. $H_2O = 5{\cdot}3$.

0·1166 * gave 0·3466 CO_2 and 0·1216 H_2O. $C = 81{\cdot}1$; $H = 11{\cdot}6$.

$C_{31}H_{52}O_2,1\frac{1}{2}H_2O$ requires $H_2O = 5{\cdot}6$ per cent.

$C_{31}H_{52}O_2$ requires $C = 81{\cdot}5$; $H = 11{\cdot}4$ per cent.

* Anhydrous substance.

A determination of the specific rotatory power gave the following result: 0·2362,* made up to 20 c.c. with chloroform, gave α_D −40′ in a 2-dcm. tube, whence $[\alpha]_D$ −28·2°.

The above-described substance gave with acetic anhydride and sulphuric acid a colour reaction similar to that produced by the phytosterols, but differs from the latter, inasmuch as it becomes red when moistened with strong sulphuric acid. It also differs from the phytosterols by the presence of two oxygen atoms, although containing but one hydroxyl group. As it is a new compound, it is proposed to designate it *euonysterol.*

Euonysteryl Acetate, $C_{31}H_{51}O_2{\cdot}CO{\cdot}CH_3$.—This derivative, when recrystallised from ethyl acetate, separated in laminæ melting at 116—118°:

0·1424 gave 0·4156 CO_2 and 0·1426 H_2O. C = 79·5; H = 11·1.
0·1174 „ 0·3410 CO_2 „ 0·1158 H_2O. C = 79·2; H = 10·9.
$C_{33}H_{54}O_3$ requires C = 79·5; H = 10·8 per cent.

Isolation of a New Monohydric Alcohol, Homo-euonysterol, $C_{40}H_{69}O{\cdot}OH$.

Although euonysterol represented the chief portion of the previously described mixture, the more soluble acetyl derivative, when decomposed with alcoholic potassium hydroxide, gave a product which separated from a mixture of ethyl acetate and dilute alcohol in laminæ, melting at 133—134°:

0·0997, on heating at 110°, lost 0·0050 H_2O. H_2O = 5·0.
0·0947 * gave 0·2850 CO_2 and 0·1052 H_2O. C = 82·1; H = 12·3.
$C_{40}H_{70}O_2,1\frac{1}{2}H_2O$ requires H_2O = 4·6 per cent.
$C_{40}H_{70}O_2$ requires C = 82·5; H = 12·0 „ „

This compound is evidently a homologue of the previously described alcohol, differing from it by the increment $9CH_2$, and it is therefore proposed to designate it *homo-euonysterol.* Like euonysterol, it became red when moistened with sulphuric acid.

Homo-euonysteryl Acetate, $C_{40}H_{69}O{\cdot}CO{\cdot}CH_3$.—This derivative separated from acetic anhydride in leaflets melting at 128—130°:

0·1040 gave 0·3068 CO_2 and 0·1064 H_2O. C = 80·5; H = 11·4.
$C_{42}H_{72}O_3$ requires C = 80·7; H = 11·5 per cent.

Isolation of a New Dihydric Alcohol, Atropurol, $C_{27}H_{44}(OH)_2$.

The original alcoholic mother liquor from the above-described mixture of alcohols was concentrated to about 100 c.c., when, on keeping for a few days, a quantity (2·0 grams) of a crystalline product separated. This was dissolved in a mixture of ethyl

* Anhydrous substance.

acetate and alcohol, when, on cooling, a substance separated in needles melting at 283—285° without decomposition. It was anhydrous, and optically inactive:

0·1196 gave 0·3530 CO_2 and 0·1248 H_2O. C = 80·5; H = 11·6.
$C_{27}H_{46}O_2$ requires C = 80·6; H = 11·4 per cent.

This substance gave with acetic anhydride and sulphuric acid, colour reactions similar to those of the phytosterols, but when moistened with sulphuric acid it gave no colour. It is isomeric with homo-olestranol, which was isolated from olive leaves (Trans., 1908, **93**, 901), although not identical with it, and as it does not conform in its properties to any other substance of this formula, it is a new compound. It is therefore proposed to designate it *atropurol*, with reference to the source from which it has been isolated.

Atropuryl Acetate, $C_{27}H_{44}O_2(CO\cdot CH_3)_2$.—This was prepared by heating atropurol for some time with acetic anhydride, the product being then crystallised from a mixture of ethyl acetate and alcohol, when it separated in very small needles melting at 169—170°:

0·0938 gave 0·2620 CO_2 and 0·0874 H_2O. C = 76·2; H = 10·3.
$C_{31}H_{50}O_4$ requires C = 76·5; H = 10·3 per cent.

The original mother liquors from which the above-described alcoholic substances had been separated yielded on evaporation a viscid product amounting to about 50 grams, but from which nothing definite could be obtained.

Isolation of Citrullol, $C_{22}H_{36}O_2(OH)_2$.

The alkaline, aqueous liquid which had been extracted with ether to remove the unsaponifiable material, as described above, was acidified, when a quantity of fatty acid was precipitated. This was extracted with ether, when a small amount of a sparingly soluble substance was separated by filtration. The latter was crystallised several times from a mixture of pyridine and ethyl acetate, when it was finally obtained in colourless, microscopic needles, melting and decomposing at 285—290°. It gave colour reactions resembling those of ipuranol (*Amer. J. Pharm.*, 1908, **80**, 264, 576) and other similar alcohols. The substance agreed in all its properties with the dihydric alcohol, citrullol, which was first obtained by Power and Moore (Trans., 1910, **97**, 102) from colocynth. (Found, C = 71·9; H = 10·7. Calc., C = 72·1; H = 10·4 per cent.)

The diacetyl derivative was prepared by boiling a small quantity of the alcohol with acetic anhydride. It separated from dilute

alcohol in leaflets, melting at 164—165°. (Found, C = 69·0; H = 9·3. Calc., C = 69·3; H = 9·3 per cent.)

Identification of the Fatty Acids.

The ethereal liquid from which the citrullol had been separated was dried and the solvent removed, when there remained a quantity (320 grams) of a dark-coloured product, consisting of a mixture of fatty acids. A convenient quantity (160 grams) of this product was esterified with methyl alcohol and dry hydrogen chloride, and the methyl esters of the acids distilled under diminished pressure. Two fractions were thus obtained, the first of which passed over between 200° and 230°/15 mm. as a light yellow oil, whilst the second distilled between 240° and 280°/15 mm. as a very viscid, dark yellow oil, which solidified on cooling to a waxy mass.

Fraction 200—230°/15 mm.—This fraction, which was optically inactive and amounted to 105 grams, was hydrolysed with an alcoholic solution of potassium hydroxide, and, after removing most of the alcohol, was diluted with water and exactly neutralised with acetic acid. To the hot liquid an excess of a boiling solution of lead acetate was added, and the precipitated lead salts washed and digested with ether, when a considerable portion was dissolved. The soluble portion of the lead salts yielded 60 grams of liquid acids, whilst the insoluble portion yielded 25 grams of solid acids.

The Liquid Acids.—These acids when distilled under diminished pressure passed over between 215° and 260°/20 mm. as a yellow oil. An analysis and a determination of the iodine value gave the following results:

0·1678 gave 0·4704 CO_2 and 0·1738 H_2O. C = 76·5; H = 11·5.
0·2304 absorbed 0·3373 Iodine. Iodine Value = 146·4.
$C_{18}H_{34}O_2$ requires C = 76·6; H = 12·1 per cent. I.V. = 90·1.
$C_{18}H_{32}O_2$ „ C = 77·1; H = 11·4 „ „ I.V. = 181·4.

It is evident from the above results that the liquid acids consist of a mixture of oleic and linolic acids.

The Solid Acids.—These acids were again converted into their methyl esters, and the resulting product fractionated many times under diminished pressure, when the following fractions were finally obtained: (1) Below 194°; (2) 194—195°; (3) 195—200°; (4) 200—205°; (5) 205—220°/20 mm. The first fraction, after hydrolysis, yielded an acid which, when repeatedly crystallised from ethyl acetate, separated in shining laminæ melting at 62—63°:

0·1295 gave 0·3520 CO_2 and 0·1444 H_2O. C = 74·1; H = 12·4.
0·1100 neutralised 0·2465 KOH. Neutralisation Value = 224·1.

A silver salt of the acid, which was precipitated in three fractions, gave Ag = 29·6, 29·8, and 30·2 respectively:

$C_{16}H_{32}O_2$ requires C = 75·0; H = 12·5; Ag = 29·7 per cent.

Neutralisation Value = 219.

It would appear that this fraction consisted of palmitic acid with a small amount of a lower acid.

Fractions 2, 3, *and* 4 solidified to crystalline masses, and they were separately hydrolysed. The regenerated acids when recrystallised from ethyl acetate separated in laminæ melting at 61—63°, 61—63°, and 60—61° respectively. Each fraction was found by analysis to consist of palmitic acid. (Found, C = 75·0; H = 12·6. C = 74·7; H = 12·5. C = 75·0; H = 12·5 respectively. Calc., C = 75·0; H = 12·5 per cent.)

Fraction 5 did not solidify on long keeping, but deposited a few laminæ on cooling. It was hydrolysed, when palmitic acid (m. p. 60—61°) was obtained, together with a small amount of unsaturated acid.

Fraction 240—280°/15 mm.—This fraction, which amounted to 5 grams, was hydrolysed, and the regenerated acid recrystallised first from alcohol and then fractionally from ethyl acetate. Three fractions were thus obtained, which consisted of shining laminæ melting at 75—76°, 74—76°, and 75—77° respectively. After drying at 110° they were analysed:

0·1486 gave 0·4264 CO_2 and 0·1756 H_2O. C = 78·3; H = 13·1.
0·1002 „ 0·2856 CO_2 „ 0·1194 H_2O. C = 77·7; H = 13·2.
0·1041 „ 0·2970 CO_2 „ 0·1212 H_2O. C = 77·8; H = 12·9.

$C_{26}H_{52}O_2$ requires C = 78·8; H = 13·1 per cent.

It would thus appear that the product from the last-mentioned fraction of esters consisted of cerotic acid, together with some lower acid.

Ether, Chloroform, Ethyl Acetate, and Alcohol Extracts of the Resin.

These extracts were dark crimson masses, amounting to 150, 39, 50, and 30 grams respectively. They possessed a bitter taste, especially the portion soluble only in alcohol. Nothing definite could be obtained from any of them, nor were they glucosidic.

Summary.

The results of the present investigation may briefly be summarised as follows:

The material employed for this investigation consisted of the root-bark of *Euonymus atropurpureus*, Jacquin. An alcoholic

extract of this material when distilled in a current of steam yielded an amount of a pale yellow essential oil equivalent to 0·01 per cent. of the weight of the drug.

The portion of the extract which was soluble in water contained a quantity of dulcitol amounting to 2·09 per cent. of the weight of the drug; a new acid, $C_5H_4O_3$, melting at 121—122°, which evidently is *furan-β-carboxylic acid*; a new crystalline alcohol, $C_{21}H_{30}O_4$ (m. p. 248—250°), which has been designated *euonymol*; and a sugar which yielded *d*-phenylglucosazone (m. p. 208—209°), together with small amounts of tannin and colouring matter.

The portion of the extract which was insoluble in water consisted of a dark brown resin amounting to 3·2 per cent. of the weight of the drug. From this resin the following substances were isolated: Three new alcohols, namely: *Euonysterol*, $C_{31}H_{51}O{\cdot}OH$ (m. p. 137—138°; $[\alpha]_D$ −28·2°); *homoeuonysterol*, $C_{40}H_{69}O{\cdot}OH$ (m. p. 133—134°); *atropurol*, $C_{27}H_{44}(OH)_2$, melting at 283—285°; citrullol, $C_{22}H_{36}O_2(OH)_2$, which has previously been obtained from colocynth (Trans., 1910, **97**, 102); and a mixture of fatty acids consisting of palmitic, cerotic, oleic, and linolic acids.

In the course of this investigation no product could be obtained corresponding with the "euonymin" described by Schmiedeberg (*Arch. exp. Path. Pharm.*, 1883, **16**, 163), and subsequently by Romm (*Pharm. Centr-h.*, 1885, **26**, 220) as a crystalline glucoside, which is stated to have been isolated by Hans Meyer from the bark of *Euonymus atropurpureus*. Moreover, there was no evidence of the presence of any glucosidic substance in the bark.

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